MOUNTAIN RESEARCH STATION

ITS ENVIRONMENT AND RESEARCH

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POLARPAM

Long-Term Ecological Research
Institute of Arctic and Alpine Research
University of Colorado, Boulder

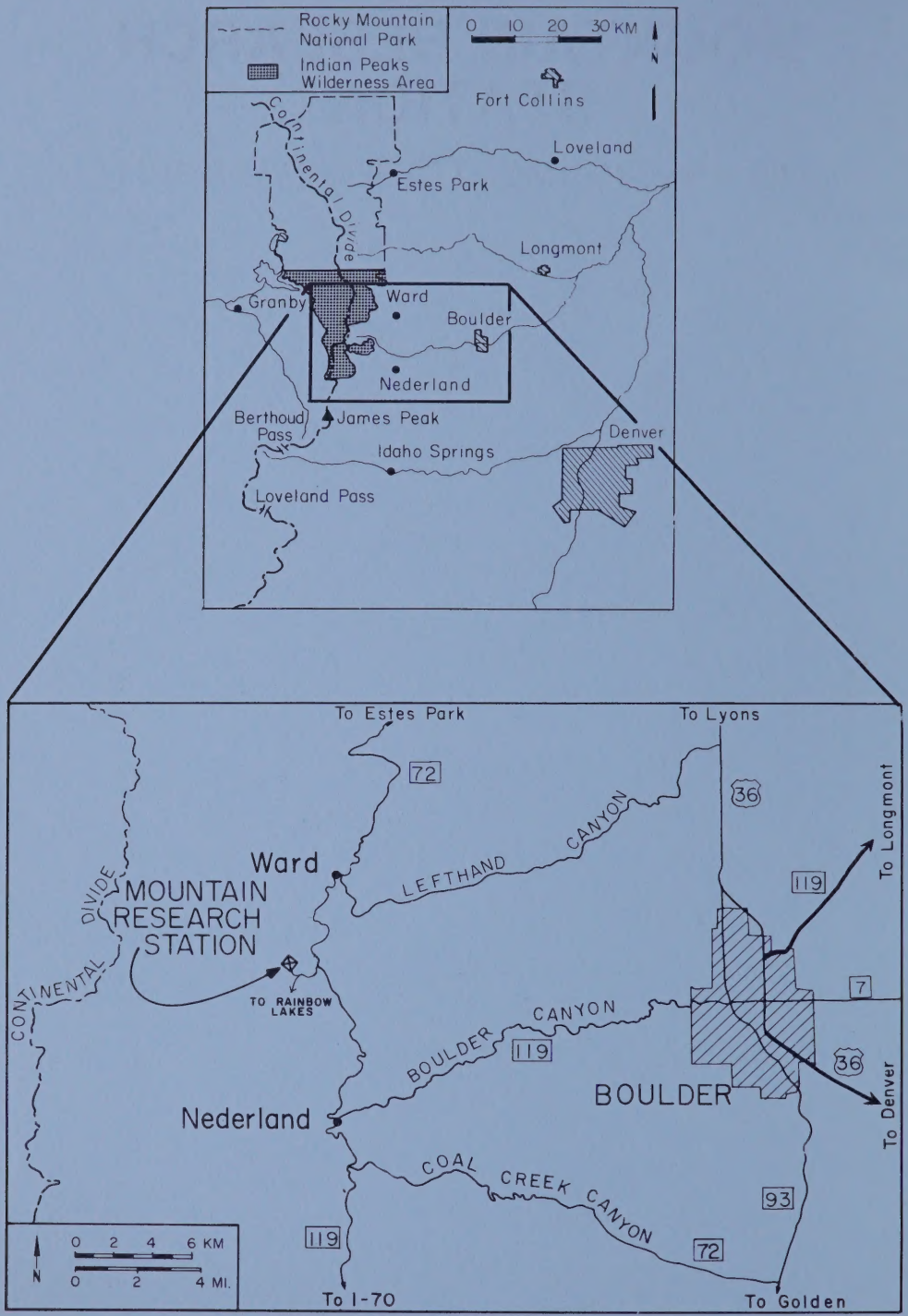

Figure 1. Location of the Mountain Research Station and route map.

THE MOUNTAIN RESEARCH STATION

Scientists, students, and members of the public have studied and contemplated the unspoiled alpine and subalpine environments of the University of Colorado's Mountain Research Station for almost 60 years. The Mountain Research Station offers special opportunities for study to those interested in learning more about the Colorado mountains. Only through understanding can we hope to mitigate the impact of increasing human activity in the mountains.

This guidebook, intended as a welcome to investigators, offers a brief description of the University of Colorado's Mountain Research Station. Included are a brief history, a statement of the missions and goals, and a summary of research topics, both past and present. This material provides a background for scientists interested in working at the Mountain Research Station (MRS), for students, and for the public.

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DESCRIPTION AND HISTORY

The Mountain Research Station, located in the Colorado Front Range, is an interdisciplinary field research and teaching facility managed by the Institute of Arctic and Alpine Research (INSTAAR) and devoted to advancement of the study of high mountain ecosystems. The Institute of Arctic and Alpine Research was established in 1951 by the Board of Regents of the University of Colorado. INSTAAR and the Mountain Research Station are part of the Graduate School. They receive academic contributions from the departments of Environmental, Population, and Organismic Biology (EPO Biology); Geography; and Geological Sciences on the Boulder campus. In addition to the activities of the University of Colorado scientists, studies are conducted by research associates with various specialities.

The Mountain Research Station, a small, self-contained settlement, is located in the forest 2910 m above sea level on the flank of Niwot Ridge. The station is 41 km west of Boulder and 5 km east of the Continental Divide (Figure 1). Surrounded by 4000 m peaks, MRS has a view to the east which encompasses foothills and hogbacks bordering the western edge of the High Plains, 1.5 km above sea level. The Mountain Research Station is an 80-hectare parcel of University-owned land, surrounded by a large research area administered by the United States Forest Service (Figure 2). The University-owned portion is bounded by Niwot Ridge on the north, Colorado Highway 72 on the east, and the Boulder City Watershed on the south and west. Rocky Mountain National Park and its gateway town of Estes Park are a one-hour drive north. Researchers have access to the Forest Service land, and, by special agreement, may work in the restricted Boulder City Watershed. The Watershed has been closed to the public since 1920.

The Mountain Research Station began in 1914 as a recreational retreat for University of Colorado faculty; but its more relevant history dates back to 1920, when the current site was chosen, and to 1921, when the station (originally called University Camp, later Science Lodge) was built.

Dr. John W. Marr saw the potential for teaching ecology courses at the Mountain Research Station in 1947. He was especially interested in winter ecology and was instrumental in establishing the station as a year-round facility for research and education. Dr. Marr was appointed founding director of the Institute of Arctic and Alpine Research in 1951, a post he held until 1967. He obtained several large grants which were used to expand and upgrade the facilities and equipment at the station. Some of these early grants were for the study of cold-weather equipment and clothing (Army Research Office), the establishment of a climate monitoring network (Army Research Office), the training of high school students and teachers (National Science Foundation), and the conducting of watershed research (Atomic Energy Commission). Dr. Marr was one of the first professors from the University of Colorado to receive outside grants to support research activities, and his watershed experiments were among the first ecosystem studies in the world. His enormous knowledge, tireless dedication, and personal involvement did much to establish the Mountain Research Station and its research facilities. Dr. Marr's last major project was the building of the Alpine Laboratory in 1963 which was renamed the John W. Marr Alpine Laboratory in July 1982.

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In 1967, Dr. Jack D. Ives succeeded Dr. Marr as director. Although the Mountain Research Station has always received financial support from the state of Colorado, Dr. Ives sought out and obtained important research grants. Projects initiated under these new grants included the San Juan Ecology Project (Bureau of Land Management), International Biological Programme Tundra Biome Project (National Science Foundation), and various mapping projects (National Aeronautical and Space Administration). Dr. Ives substantially expanded faculty and graduate student involvement in year-round MRS research and improved the station's physical facilities.

Dr. Ives secured a new position from the University—that of resident mountain station director. Dr. Michael C. Grant, now chairman of the Department of Environmental, Population, and Organismic Biology on the Boulder campus, was director from 1974 to 1976. The station was designated an Experimental Ecological Reserve during his tenure. Dr. David E. Greenland, now associate professor of geography on the Boulder campus, was director from 1976 to 1978. Misha Plam became director in the fall of 1978. He established a firm basis for ongoing atmospheric research by NOAA, CIRES, and the Ford Motor Company.

In May 1979, the Niwot Ridge Research area was designated a Biosphere Reserve, largely through the efforts of Dr. Ives. His association with the UNESCO Man and the Biosphere Program (MAB) let him draw together the U.S. State Department, the U.S. Forest Service, and local personnel to achieve the Biosphere Reserve status.

Dr. James C. Halfpenny is the present field director of MRS and Dr. Patrick J. Webber is director of INSTAAR. The Long-Term Ecological Research project of the University of Colorado is conducted at the Niwot Ridge site under their direction.

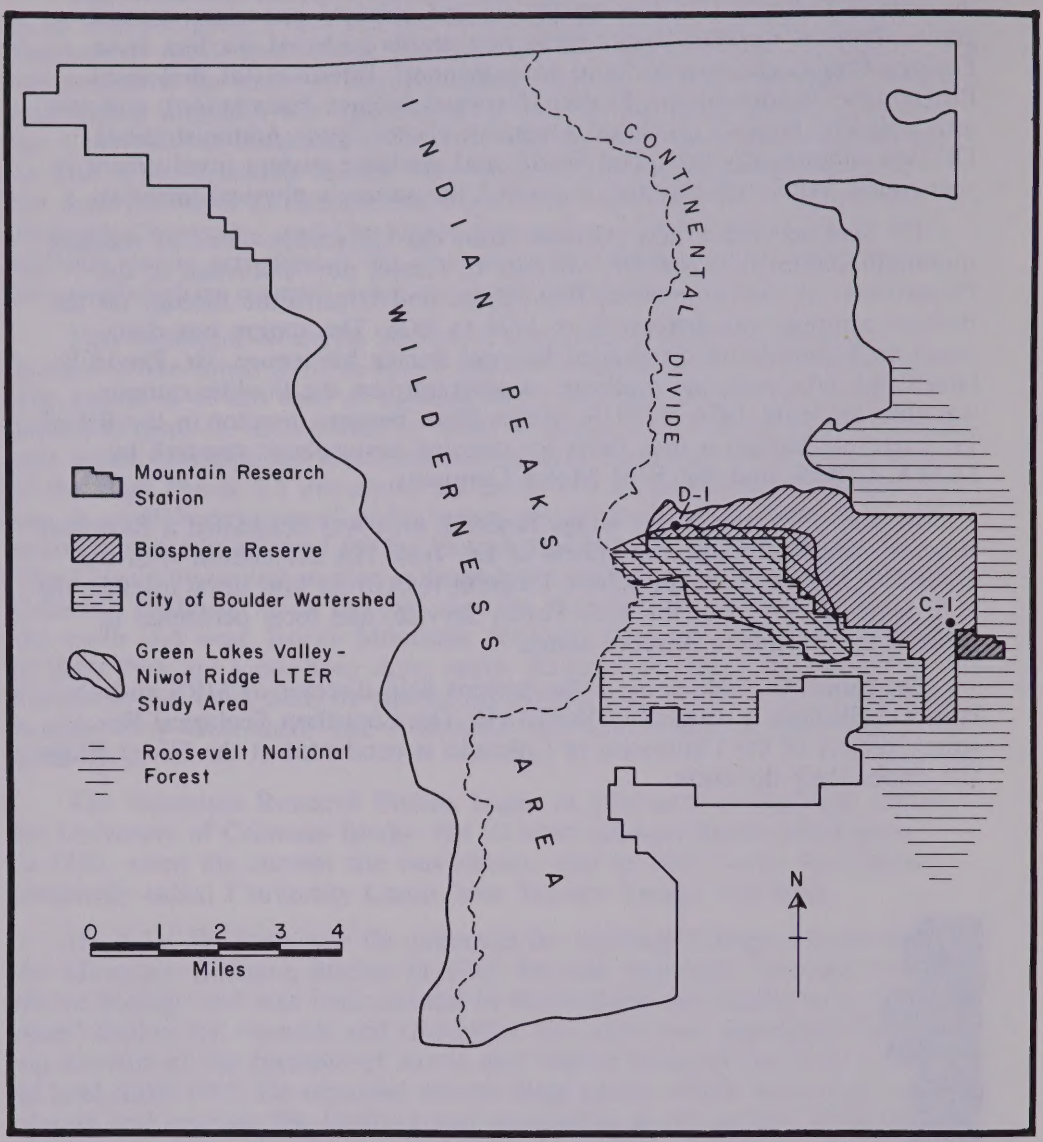


Figure 2. Political environment of the Mountain Research Station.

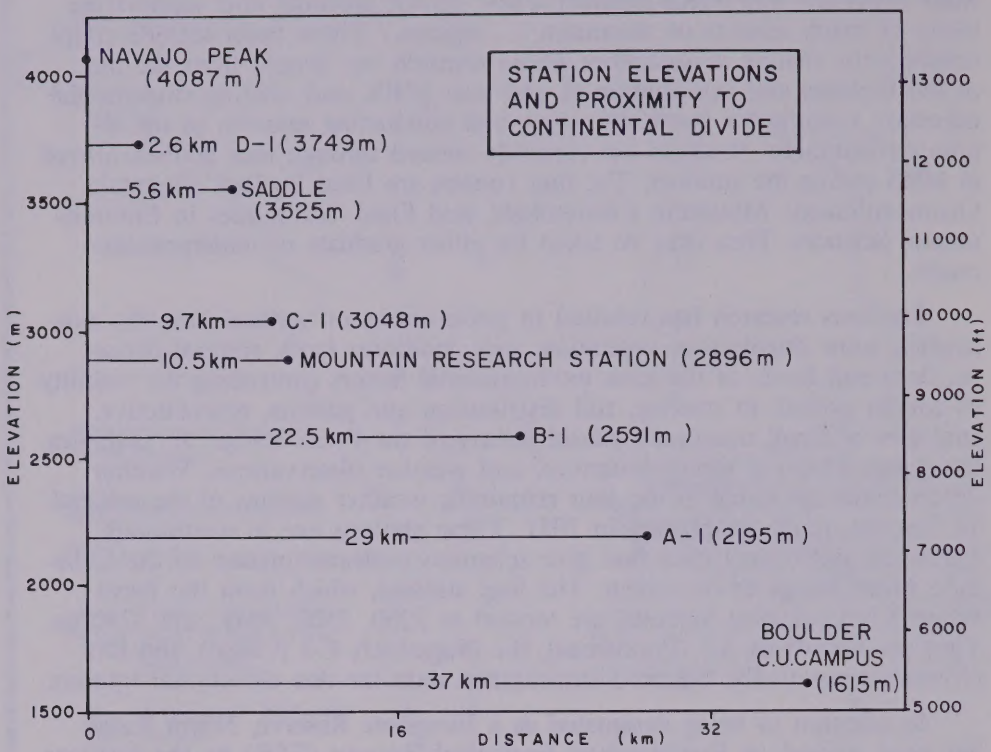
OBJECTIVES OF THE MOUNTAIN RESEARCH STATION

The purpose of MRS is to foster an increased understanding of all ecosystems with emphasis on the alpine and subalpine environments. Dr. Marr proposed that MRS conduct tasks "which promote and support the study of many aspects of mountain . . . regions." These tasks include cooperating with visiting investigators whose research can benefit from the use of the facilities and information at and near MRS, and offering students the necessary training for living, traveling, and conducting research in the alpine environment. Students are currently trained through four courses offered at MRS during the summer. The four courses are Field Ecology, Mountain Geomorphology, Mountain Climatology, and Field Techniques in Environmental Sciences. They may be taken for either graduate or undergraduate credit.

Previous research has resulted in publications on natural hazards, avalanches, snow distribution, vegetation, soils, landform types, surficial deposits, flora and fauna of the area, environmental factors controlling the viability of conifer growth at treeline, soil distribution and genesis, reproductive strategies of small mammals, glacial history of the Front Range, air pollution, forest tree genetics, forest dynamics, and weather observations. Weather observations are made at the four remaining weather stations of the original 16 that Dr. Marr established in 1951. These stations are in continuous operation and collect data that give scientists a clearer picture of the Colorado Front Range environment. The four stations, which form the Front Range Climatological Stations, are located at 2200, 2500, 3048, and 3750 m. They are known as A-1 (Ponderosa), B-1 (Sugarloaf), C-1 (Como), and D-1 (Niwot), respectively. Figure 3 summarizes data for this elevational transect.

In addition to being designated as a Biosphere Reserve, Niwot Ridge has been named an Experimental Ecological Reserve (EER) by the Institute of Ecology. Niwot Ridge has also been selected as one of 11 Long-Term Ecological Research sites by the National Science Foundation.

The philosophy behind these designations and projects considers that humans are integral parts of their environment who depend upon the environment for survival. Therefore, increased understanding of all environmental systems is crucial to human survival. The work currently being done at the Mountain Research Station supports both the Long-Term Ecological Research (LTER) project and the philosophical aims of those who established INSTAAR and MRS.



Station	Mean Annual Temperature °C(°F)	Mean Annual Wind Speed m/sec(mph)	Mean Annual Precipitation cm(inches)	Frost-Free Days	Mean Annual Radiation cal/cm²/day
A-1	8.00(46.4)	—	54.48(21.4)	131	—
B-1	5.65(42.2)	2.1(4.7)	55.09(21.7)	109	345.0
C-1	1.25(34.3)	3.4(7.6)	77.06(30.3)	67	335.6
D-1	−3.75(25.3)	10.3(23.0)	102.08(40.2)	47	355.3

Figure 3. Location and climate information for Front Range Climatological Stations.

Pika
Ochotona princeps

ENVIRONMENT

The geological setting of MRS features igneous, sedimentary, and metamorphic rocks, ranging from Precambrian to Recent in age. The core of the Colorado Front Range and of the Niwot Ridge area is largely "acidic Precambrian intrusives, themselves intruded by acidic Tertiary plutons." Geomorphologists will find a wide variety of landforms, including alpine glaciers, rock glaciers, and such periglacial features as active and dormant patterned ground, talus slopes, and avalanche paths.

Five distinct ecoregions are within a one-hour drive from the station. These regions are Great Plains Grassland, Lower Montane Forest, Upper Montane Forest, Subalpine Forest, and Alpine Tundra. Numerous alpine and subalpine lakes, ponds, and bogs are readily accessible.

The relief from the High Plains to the crestline of the Continental Divide is approximately 2900 m and encompasses several life zones of flora and fauna (Figure 4). There are treeless mountains, with abundant alpine plant and animal life; forested mountains with a diversified terrestrial biota including deer, elk, mountain lion, and coniferous trees and lakes, ponds, and streams which support aquatic life; and treeless semi-arid plains rich with cacti, sagebrush, prairie dogs, jackrabbits, antelope, rattlesnakes, and various birds.

The tundra location, diversified topography, geologic history, and varied biota contributed to Niwot Ridge being named a Biosphere Reserve in 1979. UNESCO designated the term Biosphere Reserve to mean an area with up to four distinct uses, each use occurring in a separate portion of the reserve. These distinct uses are education, manipulative research, non-manipulative research, and preservation. Biosphere Reserves are recognized by federal governments, and the Niwot Ridge Biosphere Reserve is part of the Roosevelt National Forest.

C-1 Weather Station
3048 m (10,000 ft)

	Mean Monthly Precipitation		Mean Monthly Temperature		Temperature Extremes		Mean Monthly Wind Speed		Mean Monthly Radiation
	cm	(inches)	°C	(°F)	High °C(°F)	Low °C(°F)	m/sec	mph	cal/cm²/day
Jan	4.83	(1.90)	−7.4	(18.8)	12(53.6)	−37(−34.6)	5.8	(13.0)	186.5
Feb	4.90	(1.93)	−7.0	(19.5)	13(55.4)	−32(−25.6)	3.1	(6.9)	290.4
Mar	7.09	(2.79)	−6.1	(21.1)	12(53.6)	−29(−20.2)	3.9	(8.7)	378.9
Apr	7.72	(3.04)	−1.5	(29.3)	17(62.6)	−22(−7.6)	3.3	(7.4)	513.1
May	9.55	(3.76)	4.3	(39.7)	21(69.8)	−16(3.2)	2.8	(6.3)	473.1
June	8.36	(3.29)	8.5	(47.3)	25(77.0)	−7(19.4)	2.2	(4.9)	405.3
July	8.15	(3.21)	12.0	(53.6)	25(77.0)	−2(28.8)	1.9	(4.3)	387.7
Aug	6.17	(2.43)	11.1	(52.0)	25(77.0)	−7(19.4)	2.0	(4.5)	402.9
Sept	5.61	(2.21)	7.6	(45.6)	25(77.0)	−14(6.8)	2.2	(4.9)	307.0
Oct	4.72	(1.86)	3.3	(37.9)	18(64.4)	−18(0.4)	3.6	(8.1)	311.9
Nov	5.44	(2.14)	−3.0	(26.6)	13(55.4)	−27(−16.6)	4.3	(9.6)	202.7
Dec	4.52	(1.78)	−6.3	(20.7)	13(55.4)	−27(−16.6)	4.4	(9.8)	167.7
TOTAL YEARLY	77.06	(30.34)							
MEAN YEARLY	6.43	(2.53)	1.25	(34.3)			3.4	(7.6)	335.6

Data from Barry, 1973.

Table 1. Climate data from C-1 weather station at 3048 m (10,000 feet).

CLIMATE

Great contrast describes the seasons at the station. Summer is cool, with many clear, bright mornings and partly cloudy afternoons, which are frequently marked by short thunder showers. Temperatures are about 15°C lower than those found on the nearby plains. Nighttime lows are usually just above freezing. Wet cool days or those with maxima about 20°C occasionally occur. Because of its southeastern exposure, the station receives a lot of sunlight, which makes the thin air feel warmer than might be expected from the actual air temperatures. The weather is much cooler and windier in the nearby alpine regions.

Winter visitors to MRS will experience severe conditions, with very cold temperatures and high winds (Tables 1 and 2). Meteorologists have described the Colorado Front Range and the Niwot Ridge area as some of the windiest places in the world, outdone only by Fujiyama in Japan, Mt. Washington in New Hampshire, and areas of the Antarctic. The two highest stations (C-1 and D-1) experience the greatest wind velocities between October and March with January cited as the windiest month of the year. The D-1 Station (Niwot Ridge) may have wind gusts in excess of 45 m/sec (100 mph) nine months of the year.

Severe conditions create serious danger of frostbite if appropriate measures for protecting skin surfaces are overlooked. The C-1 Station "has only four months of the year when the mean monthly minimum temperatures are above 0°C...and temperature records show that freezing temperatures can occur at any time during the year. Over an 18-year period, frost-free days average only 59 at this site. At the higher station, D-1, the mean annual air temperature of -3.8°C ... is almost identical with that of Nome, Alaska (64°N)."

Deep snow drifts often accumulate in the tundra; however, the alpine tundra is characterized by the persistence of windswept, snowfree areas. Although high winds remove a lot of snow, visitors should equip their vehicles with snow tires by November. The station maintains a fleet of over-snow and four-wheel drive vehicles to enable researchers to get around the area with relative ease.

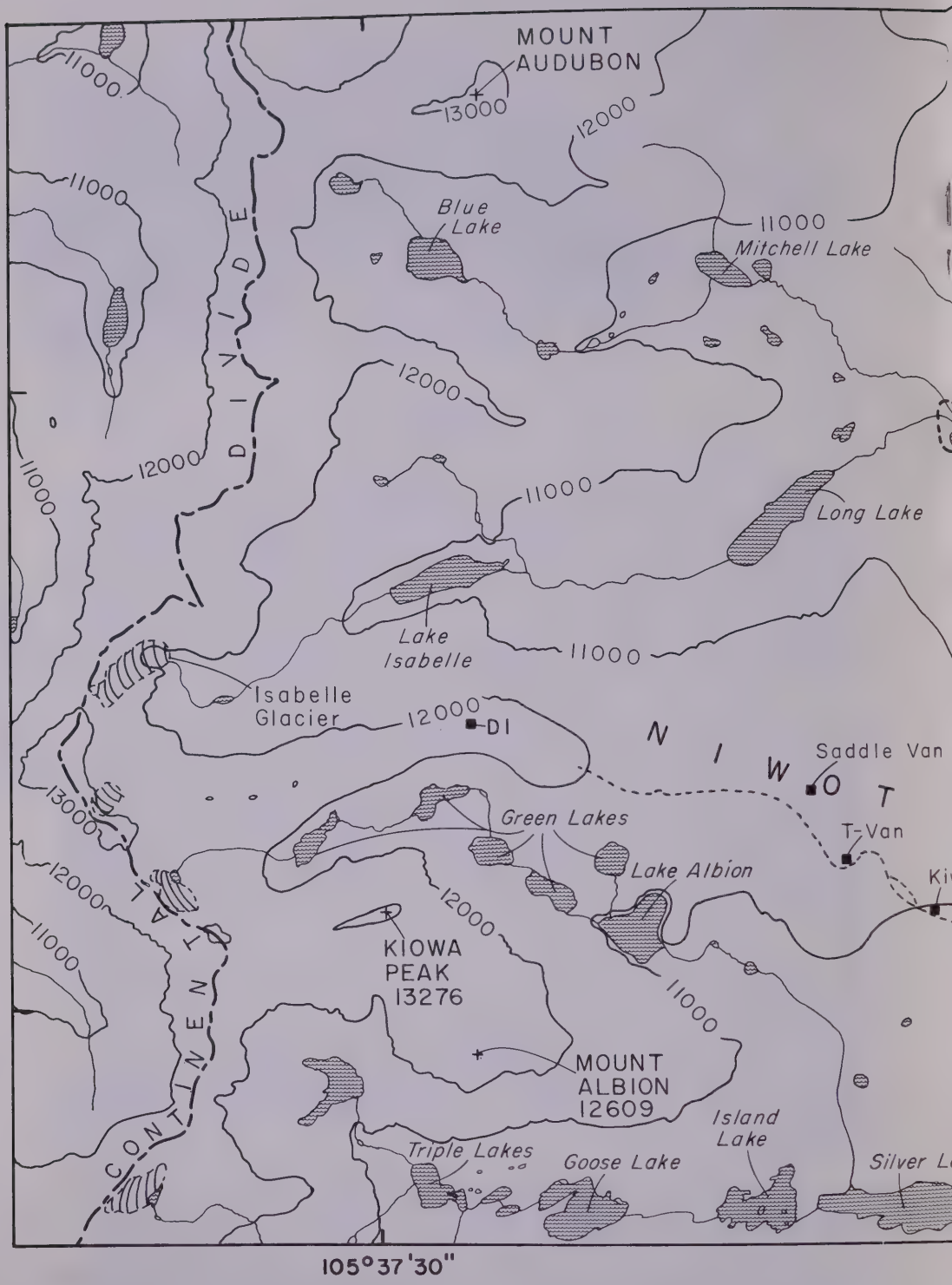
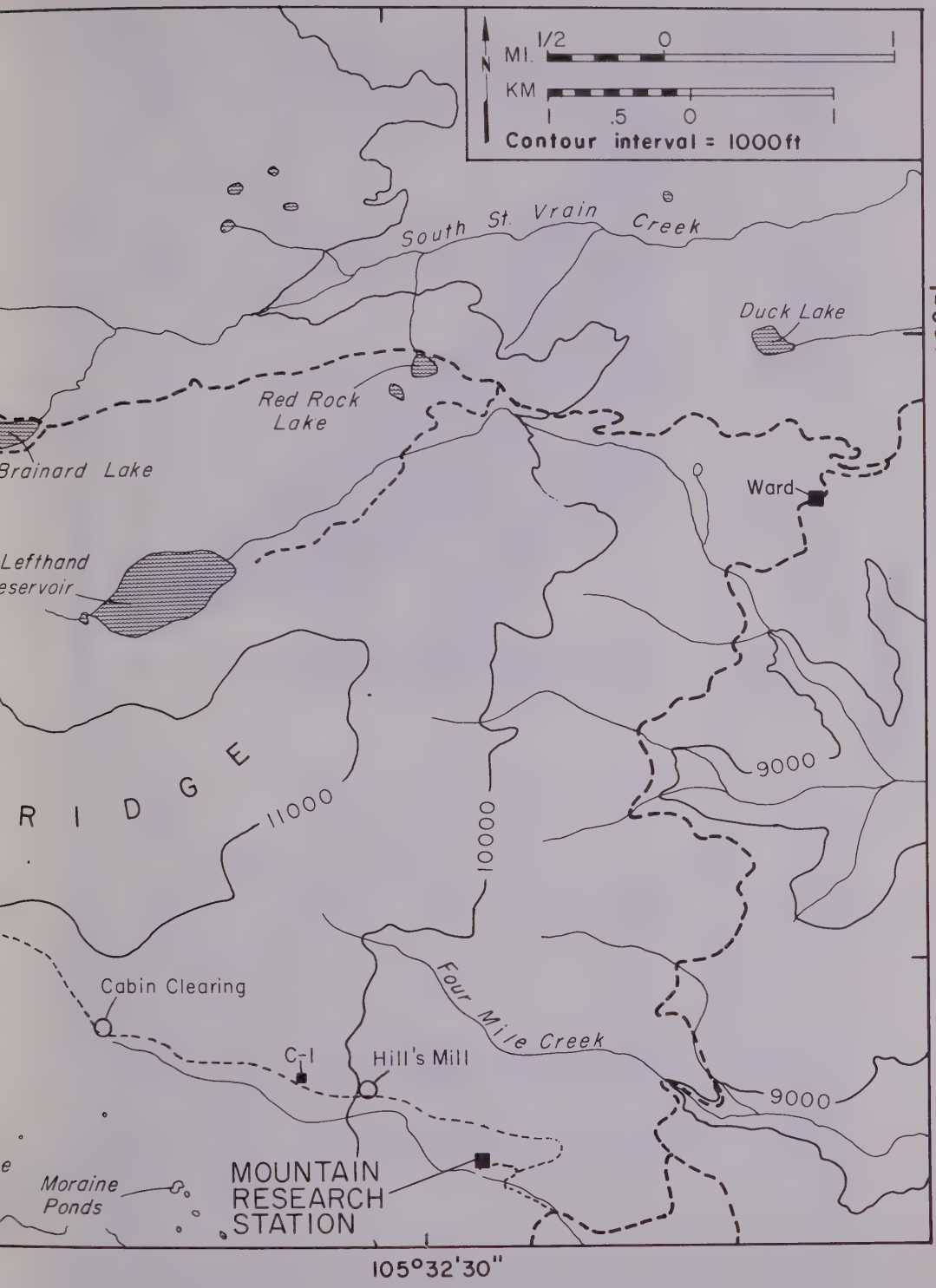


Figure 4. Topographic map of Niwot Ridge and



urroundings. Contour interval is 1000 feet.

D-1 Weather Station
3750 m (12,300 ft)

	Mean Monthly Precipitation		Mean Monthly Temperature		Temperature Extremes		Mean Monthly Wind Speed		Mean Monthly Radiation
	cm	(inches)	°C	(°F)	High °C(°F)	Low °C(°F)	m/sec	mph	cal/cm²/day
Jan	13.77	(5.42)	−13.2	(8.3)	4(39.2)	−37(−34.6)	13.9	(31.1)	180.0
Feb	9.07	(3.57)	−13.3	(8.2)	5(41.0)	−32(−25.6)	11.8	(26.4)	293.6
Mar	10.54	(4.15)	−11.7	(10.9)	5(41.0)	−30(−22.0)	12.1	(27.1)	343.9
Apr	10.19	(4.01)	−7.4	(12.0)	11(51.8)	−22(−7.6)	9.5	(21.3)	503.7
May	6.78	(2.67)	−0.8	(30.7)	14(57.2)	−22(−7.6)	8.9	(19.9)	513.2
June	6.99	(2.75)	4.6	(40.2)	19(66.2)	−12(10.4)	7.8	(17.4)	472.5
July	8.03	(3.16)	8.5	(47.2)	18(64.4)	−3(26.6)	5.8	(13.0)	482.6
Aug	5.72	(2.25)	7.4	(45.2)	18(64.4)	−7(19.4)	5.7	(12.8)	451.0
Sept	7.16	(2.82)	3.3	(37.9)	16(60.8)	−14(6.8)	7.9	(17.7)	347.0
Oct	3.89	(1.53)	−1.9	(28.7)	11(51.8)	−22(−7.6)	12.5	(28.0)	325.5
Nov	11.20	(4.41)	−8.6	(16.6)	7(44.6)	−29(−20.2)	13.4	(30.0)	181.3
Dec	8.76	(3.45)	−12.2	(10.0)	4(39.2)	−32(−25.6)	13.6	(30.4)	169.0
TOTAL YEARLY	102.08	(40.19)							
MEAN YEARLY	8.51	(3.35)	−3.8	(25.3)			10.3	(23.0)	355.3

Data from Barry, 1973.

Table 2. Climate data from D-1 weather station at 3750 m (12,300 feet).

Ptarmigan
Lagopus leucurus

FACTS OF LIVING AT THE 700-mb LEVEL

Those who are not used to living and functioning at the high altitude of the Mountain Research Station will find that it takes some time to adjust to the reduced oxygen supply. The air becomes thinner as altitude is gained; "thinner" refers to the smaller number of oxygen molecules in the atmosphere. Atmospheric pressure, an index of this phenomenon, is measured in millibars of air pressure and is 1013 mb at sea level and 700 mb at 3000 m. Thus, air at the station contains about 70% of the oxygen that it contains at sea level. It requires 30% more person-hours, or time, to perform a physical job at the 3000-m level than it would take at sea level. Extra time should be taken into account when jobs requiring physical effort are planned. Visitors should plan an easy routine for the first few days to prevent altitude sickness.

Another inescapable fact of life at this elevation is that water boils at 88°C and not at 100°C—the sea-level boiling point. Therefore it takes longer to cook anything that is boiled and recipe adjustments must be made when baking. Foods cooked in other ways, such as frying, roasting, or broiling, require no time adjustments.

CURRENT RESEARCH ACTIVITIES

The largest current research program at MRS is the Niwot Ridge/Green Lakes Valley Long-Term Ecological Research Program (CULTER). Twenty-five professors representing four departments and two institutes at the University of Colorado comprise the CULTER team. CULTER consists of 11 subprojects: climate, water and soil, paleoecology, treeline, communities, physiological ecology, recovery, mammals, fish, aquatic invertebrates, and decomposition.

Present CULTER research emphasizes the testing of the unifying hypothesis that the alpine ecosystem reflects past climatic conditions and that perturbations will facilitate changes toward a state commensurate with the present climate. Researchers are attempting to understand how and at what rate the environment has changed since the last glaciation in order to understand and predict changes associated with current environmental disturbances. Many changes will occur in the Colorado Front Range during the next 20 years because of population growth in the greater Denver megalopolis and energy development on the west slope of the Rocky Mountains. Understanding the past will help researchers monitor, predict, and mediate these changes. Ultimately, management guidelines will be developed from CULTER research.

Other University of Colorado scientists associated with MRS are involved with tree biology, acid precipitation, stream runoff, reproductive strategies of small mammals, effects of high elevation on avian reproduction, effects of recreation on water quality, endangered mammals, preparation of an Environmental Atlas for the Indian Peaks Wilderness Area, and long-term vegetation changes.

Cooperative research is conducted with other institutions and universities, several of which are studying atmospheric chemistry. The National Oceanographic and Atmospheric Administration (NOAA) Aeronomy Laboratory, with the CU Chemistry Department, is monitoring background levels of "clean air" to understand the nonurban chemistry of atmospheric nitrogen. NOAA's program is also monitoring acid precipitation. The NOAA Geophysical Monitoring for Climate Change program measures carbon dioxide and freon. The Ford Motor Company (Research Department) monitors hydroxyl radical (OH) concentrations in "clean air" using a laser-induced fluorescence technique.

Two other groups are monitoring weather. The Soil Conservation Survey maintains a Snow Telemetry System (SNOTEL) site which relays precipitation data to two receiving stations (Boise, Idaho or Ogden, Utah) via a radio signal bounced off meteor trails. The data are transmitted by land line to Portland, Oregon for reduction and then to their offices in Fort Collins, Colorado. NOAA, under their Program for Regional Observing and Forecasting Systems (PROFS), records weather data for use in mesoscale climatic forecasting and relays it via phone line to central computers.

A synopsis of research at MRS was published in 1980. This book, *Geoecology of the Colorado Front Range,* edited by Dr. Jack D. Ives, brings together many of the early major works dealing with the research on Niwot Ridge. It is an important reference for any scientist working at MRS. Another important work, published in 1982, is *Ecological Studies in the Colorado Alpine: A Festschrift for John W. Marr,* edited by Dr. James Halfpenny.

FACILITIES

The facilities of Mountain Research Station include the John W. Marr Alpine Laboratory, 29 two-person summer cabins, 7 winterized family cabins, a winterized shower/laundry facility, classrooms, summer dining hall, and various support buildings (Figure 5). The 500 sq. m Alpine Laboratory, erected in 1963, is a modern, modestly equipped winterized building, which includes photography, soils, tree-ring, and animal laboratories; map room; herbarium; and museum. Remote-sensing, chemical, and collecting equipment and microscopes are available to researchers. Those planning to use equipment and facilities for their investigations should contact the MRS director regarding availability.

DIRECTIONS TO THE MOUNTAIN RESEARCH STATION

MRS can be reached from Boulder in less than one hour, and in summer, tree limit may be reached in one additional hour. Avalanche-free main roads form the route to the station. A route map is provided in Figure 1.

Leave Boulder by traveling west on Canyon Boulevard (Route 119), which leads up through Boulder Canyon after leaving the city. A 27 km (17 mi), well-paved winding ascent ends in Nederland. At the intersection in Nederland, bear right onto Route 72, a paved, wide road called the Peak-to-Peak Highway.

Follow the Peak-to-Peak Highway for approximately 13 km (8 mi), where a green and white rectangular sign on the right side of the road announces the University of Colorado Mountain Research Station. Just past the sign make the first left turn. Follow the dirt road for 1.5 km (0.9 mi), then take the right fork and proceed to the Alpine Laboratory, approximately 1.0 km (0.6 mi) farther.

SELECTED REFERENCES

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Greenland, D., 1977: Living on the 700 millibar surface: The Mountain Research Station of the Institute of Arctic and Alpine Research. *Weatherwise,* December: 232–238.

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Ives, J. D. (ed.), 1980: *Geoecology of the Colorado Front Range: A Study of the Alpine and Subalpine Environments.* Boulder, Colorado: Westview Press. xxvii + 484 pp.

UNIVERSITY OF COLORADO LONG-TERM ECOLOGICAL RESEARCH SUBPROJECTS - 1983

TITLE (WORKING TITLE)	INVESTIGATORS
Alpine Climatology (CLIMATE)	David E. Greenland Roger G. Barry
Hydrological and Geochemical Monitoring and Soil Development, Erosion, and Mass Wasting (WATER AND SOIL)	Nelson Caine Peter W. Birkeland J. Ernest Flack Charles M. Brendecke
Paleoenvironmental History (PALEOECOLOGY)	John T. Andrews William M. Briggs Scott A. Elias Vera Markgraf Harvey Nichols Susan K. Short
Treeline Fluctuations and Dendrochronology (TREELINE)	Katherine J. Hansen-Bristow Jack D. Ives
Dynamics of Mature Plant Communities (COMMUNITIES)	Patrick J. Webber
Plant Ecophysiology of Pollution and Disturbance (PHYSIOLOGICAL ECOLOGY)	Erik K. Bonde Jo Ann W. Flock Sam Shushan
Disturbance and Recovery of Plant Communities (RECOVERY)	Vera Komarkova
Population Dynamics of Mammalian Herbivores (MAMMALS)	Charles H. Southwick James C. Halfpenny
Fish Community Structure and Function in an Alpine Watershed (FISH)	John T. Windell
Invertebrate Populations and Diversity in a Lake-stream Chain and Neighboring Ponds (AQUATIC INVERTEBRATES)	John H. Bushnell
Bacterial Degradation of Plant Litter (DECOMPOSITION)	Wells A. Shulls Rocco L. Mancinelli

MOUNTAIN RESEARCH STATION PERMANENT STAFF

Field Director — Dr. James C. Halfpenny
Research Associate — Dr. Mark G. Noble
Senior Administrative Clerk Typist — Ms. Mori K. Maag
Plant Mechanic — Mr. T. Daniel Platt
Climatologist — Mr. Mark V. Losleben
Maintenance — Ms. Bonnie Zetta

****** INFORMATION ******

Scientists and students whose academic programs would benefit from cooperation with the Institute of Arctic and Alpine Research are invited to contact:

Dr. Patrick J. Webber, Director
Institute of Arctic and Alpine Research
Campus Box 450
University of Colorado
Boulder, CO 80309
(303) 492-7909

Scientists and students interested in working or studying at the Mountain Research Station should contact:

Dr. James C. Halfpenny, Field Director
Mountain Research Station
Institute of Arctic and Alpine Research
University of Colorado
Nederland, CO 80466
(303) 492-8841

Brochure produced by J. Halfpenny, K. Ingraham, J. Adams, and H. Peckar. June 1983.

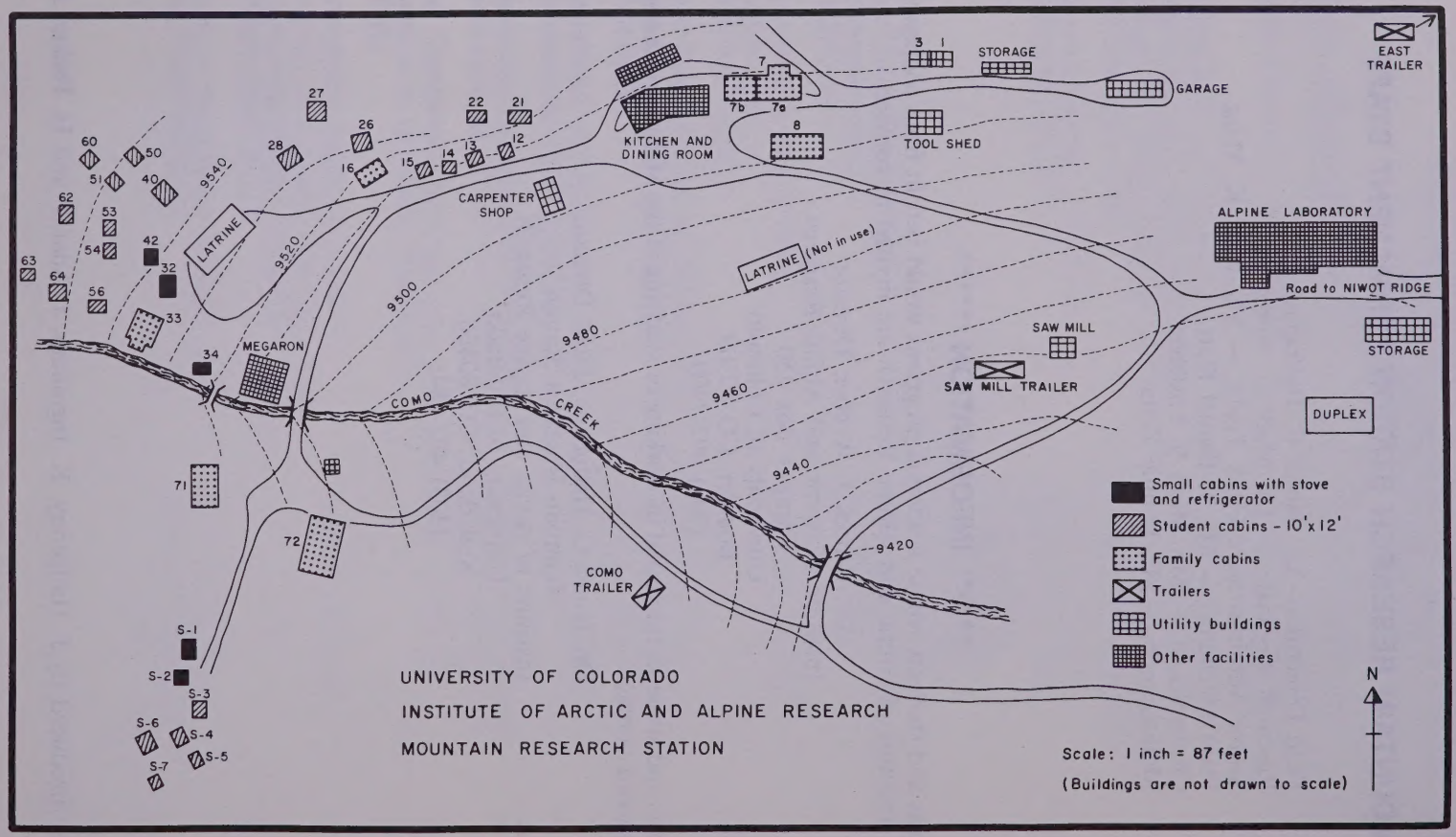

Figure 5. Mountain Research Station facilities map.

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